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The frequency of sleep disorders and their relationship with demographic factors in patients with tinnitus

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ABSTRACT

Aims: This study aimed to investigate the frequency of sleep disorders in individuals diagnosed with tinnitus and to investigate the effect of demographic factors on these disorders.

Methods: This retrospective study included 112 patients diagnosed with tinnitus between January 2018 and December 2019 at the Gazi Yaşargil Training and Research Hospital's otolaryngology clinic. The electronic files of the participants in the study were examined for sleep disorders such as insomnia, hypersomnia, inability to fall asleep, sleep terrors, sleepwalking according to ICD-9 and ICD-10 codes. The effect of demographic findings on sleep disorders were examined with multivariable regression analysis.

Result: The mean age of the study population was 38.12±11.35 years and 48.21% were female. The frequency of sleep disorders was 20.5%. The female gender ratio, body mass index (BMI), smoking users and housewife ratio were higher in the group with tinnitus and sleep disorders compared to the group with isolated tinnitus. The mean age was higher in the group with isolated tinnitus compared to the group with tinnitus and sleep disorders. Advancing age (OR= 1.33, p=0.038) and elevated BMI levels (OR=1.55, p=0.035) were associated with an increased likelihood of sleep disorders, whereas male gender (OR=0.74, p=0.038) was associated with a decreased likelihood.

Conclusion: This study demonstrated that that sleep disorders are prevalent in tinnitus patients. Advancing age and increased BMI were tied to a higher likelihood of sleep disorders in tinnitus patients, whereas male gender was linked to a reduced risk. These results indicate that demographic factors should be taken into account when managing sleep disorders in tinnitus patients.

Keywords: Hearing loss, insomnia, sleep disorders, sleep quality, tinnitus

INTRODUCTION

Tinnitus is a common clinical condition that can be seen in approximately 14% of adults and increases with age.[1] It is caused by abnormal activity within the nervous system without any internal or external acoustic stimulation.[2] Sounds such as ringing, hissing, whining, humming, buzzing and whistling are heard without any external sound.[3] It is not fully understood how tinnitus occurs and what causes it. Although there are many models explaining the pathophysiology of tinnitus, none of them explain tinnitus in all its aspects.[4] The main models are the peripheral model, which includes dysfunction in the auditory periphery such as cochlea or auditory nerve damage;[5] the central model, which is caused by changes in the central auditory pathways;[6] the gating model, which is caused by increased central auditory activity together with frontostriatal inhibitor deficiency;[7] the somatosensory model, which explains tinnitus resulting from abnormal interactions between the auditory and somatosensory systems;[8] and the inflammatory model, which has been emphasized recently.[9] Many acute or chronic diseases or clinical conditions that cause changes in vital signs can cause tinnitus with one of the above pathological patterns.[4] We think that sleep disorders are one of these clinical conditions that may be associated with tinnitus.

Sleep disorders are an important clinical condition that can affect human health and quality of life, and their frequency increases with obesity, chronic diseases and sedentary lifestyle.[10-12] Insomnia, hypersomnia, inability to fall asleep, sleep terror, sleepwalking, obstructive sleep apnea, central sleep apnea are some of these important sleep disorders.[13] Poor quality, insufficient or irregular sleep affects the endocrine, gastrointestinal, cardiovascular, nervous and cognitive functions of the human body.[14-17] Sleep disorders can be observed with a high frequency of 25 - 77% in people with tinnitus.[18] It has been reported that insomnia can be seen in approximately 50% of those with serious tinnitus.[19] In addition to insomnia, tinnitus can also be seen with a significant frequency in cases of sleep bruxism, respiratory sleep disorders and obstructive sleep apnea.[20]

In the light of this information, this study aimed to investigate

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the frequency of sleep disorders in individuals diagnosed with tinnitus and to investigate the effect of demographic factors on these disorders.

METHODS

Following the principles set forth in the Declaration of Helsinki, this retrospective study was conducted at the Diyarbakır Gazi Yaşargil Training and Research Hospital Otolaryngology Clinic from January 2018 and December 2019. The study received approval from the Gazi Yaşargil Training and Research Hospital Ethics Committee (21.07.2023 - No: 483). The need for informed consent was waived under the approval of the local ethics committee due to the retrospective design.

A total of 368 patients diagnosed with tinnitus were evaluated for eligibility according to the research criteria. Inclusion criteria included patients being between 18 and 55 years old and without any comorbidities. The age range of 18-55 years was chosen to focus on adult patients and to minimize the influence of age-related confounding factors such as presbycusis and higher prevalence of sleep disorders in the elderly.[21-24] Patients with a recent history of ear infection, ear surgery or trauma, any history of comorbidities, and those with incomplete data were excluded from the study. Following the exclusion criteria, 112 patients diagnosed tinnitus were included in the study.

The electronic files of the participants in the study were examined for sleep disorders such as insomnia, hypersomnia, inability to fall asleep, sleep terrors, sleepwalking according to ICD-9 and ICD-10 codes. The hospital's electronic information system and patient files were used to gather demographic and clinical data.

Statistical Analysis

All data were analyzed with IBM SPSS Statistics for Windows 20.0 (IBM Corp., Armonk, NY, USA). Numerical data determined to be normally distributed based on the results of Kolmogorov-Smirnov tests are given as mean and standard deviation (SD) values while non-normally distributed variables are given as median (min-max). For comparisons between groups, Student t-test and Mann-Whitney U test for two group. Categorical variables are given as numbers and percentages, and inter-group comparisons were conducted with Chi-square and Fisher exact tests. The effect of the parameters on sleep disorders was evaluated using multivariable logistic regression analysis. P<0.05 was considered statistically significant.

RESULTS

The mean age of the study population was 38.1±11.4 years and 48.21% were female. Sleep disorders (insomnia, hypersomnia, inability to fall asleep) were detected in 23 of these cases (20.5%). Eight of the patients diagnosed with sleep disorders had depression and anxiety diagnoses made in the psychiatry clinic. Clinical and demographic findings of the study population are summarized in Table 1.

The study population was divided into two groups: those diagnosed with isolated tinnitus and those with sleep disorders along with tinnitus. Comparative demographic findings of the groups are summarized in Table 2. The female gender ratio (60.9% vs. 38.2%, p=0.006, respectively), body mass index (BMI) (28.7±3.9 vs. 25.2±2.4, p=0.010, respectively), smoking users (47.8% vs. 37.1%, p=0.042, respectively) and housewife ratio (34.8% vs. 15.7%, p=0.035, respectively) were higher in the group with tinnitus and sleep disorders compared to the group with isolated tinnitus. The mean age (42.2±13.2 vs. 34.3±9.1 years, p=0.019, respectively) was higher in the group with isolated tinnitus compared to the group with tinnitus and sleep disorders (Table 2). It was determined that 57.1% of women with insomnia were housewives.

Table 1. Demographic data of patients

Variables	All population n=112
Age, year	38.1±11.4
Gender, n (%)	
Female	48 (42.9)
Male	64 (57.2)
BMI, kg/m²	27.2±3.3
Housewife, n (%)	22 (19.6)
Smoking, n (%)	44 (39.3)
Sleep disorders, n (%)	
No	89 (79.5)
Yes	23 (20.5)
Depression / anxiety, n (%)	8 (7.1)
Duration of diseases, week	
Tinnitus	27.3±12.6
Sleep disorder	20.6±10.2

Data are mean ± standard deviation or number (%). Abbreviations: BMI: Body mass index

Table 2. Distribution of demographic characteristics according to the presence of sleep disorders in tinnitus patients

Variables	Sleep disorder		p
	No n=89	Yes n=23	
Age, year	34.3±9.1	42.2±13.2	0.019*
Gender, n (%)			
Female	34 (38.2)	14 (60.9)	0.006*
Male	55 (61.8)	9 (39.1)	
BMI, kg/m²	25.2±2.4	28.7±3.9	0.010*
Housewife, n (%)	14 (15.7)	8 (34.8)	0.035*
Smoking, n (%)	33 (37.1)	11 (47.8)	0.042*

Data are mean ± standard deviation or number (%). *p<0.05 indicates statistical significance Abbreviations: BMI: Body mass index

The effect of demographic findings on sleep disorders is shown in Table 3. Advancing age (OR=1.33, 95% CI=1.09–1.72, p=0.038) and elevated BMI (OR=1.55, 95% CI=1.23–1.87, p=0.035) levels were associated with an increased likelihood of sleep disorders, whereas male gender (OR=0.74, 95% CI=0.52–0.96, p=0.038) was associated with a decreased likelihood.

Table 3. The effect of demographic characteristics on sleep disorders in tinnitus patients.

Variables	Univariable regression		Multivariable regression	
	OR (95% CI)	p	OR (95% CI)	p
Age, year	1.33 (1.09 - 1.72)	0.019*	1.33 (1.09-1.72)	0.038*
Gender, n (%)				
Female	Reference			
Male	0.70 (0.44 - 0.96)	0.006*	0.74 (0.52-0.96)	0.042*
BMI, kg/m²	1.51 (1.05 - 1.97)	0.010*	1.55 (1.23-1.87)	0.035*
Housewife, n (%)	1.54 (1.10 - 1.98)	0.035*	-	-
Smoking, n (%)	1.66 (1.14 - 2.19)	0.042*	-	-
			Nagelkerke R^2=0.268	

*p<0.05 indicates statistical significance. Abbreviations: BMI: Body mass index, CI: Confidence interval, OR: Odds ratio

DISCUSSION

In our study, we retrospectively examined the relationship between tinnitus and sleep disorders. It was determined that there was a sleep disorder rate of 20.5% in cases with tinnitus. In tinnitus patients, sleep disorders had an independent association with increasing age, higher BMI, and gender.

The relationship between tinnitus and sleep disorders can be complex and multifaceted. Sleep disorders can trigger or exacerbate tinnitus through many different mechanisms, including deterioration of vital signs, effects on cognitive functions, and physiological changes. Tinnitus can also negatively affect sleep quality through problems such as falling asleep and staying asleep. Taking these two health problems together and determining appropriate treatment approaches will play an important role in improving the quality of life of patients.

In a population-based study conducted in Japan with 14,027 participants, tinnitus was detected in 13.3% of male cases and 10.6% of female cases. Insomnia was detected in 28.1% of males and 36.1% of females with tinnitus. In cases without tinnitus, tinnitus was detected in 18.8% of males and 21.5% of females. In males and females, the probability of insomnia was found to be 1.7 times and 1.8 times higher, respectively, in those with tinnitus compared to those without tinnitus.[25] In the study conducted by Wakabayashi et al.[26] 100 cases diagnosed with tinnitus were included in the study. In this study, sleep disorders were detected in 66% of the cases. Self-rating depression scale, and state trait anxiety inventory scores were detected higher in cases with tinnitus with sleep disorders compared to cases with isolated tinnitus. It was determined that the severity of tinnitus increased with the development of sleep disorders in these cases.[26] In a study conducted by Alster et al.[27] with 80 military personnel diagnosed with tinnitus, it was determined in the mini sleep survey they conducted that 77% of the cases may have a sleep disorder. It was determined that the cases with the highest survey scores frequently had delayed sleep, morning awakenings, mid-sleep awakenings, morning fatigue and chronic fatigue. Wakabayashi et al.'s finding of higher depression and anxiety scores in tinnitus patients with sleep disorders aligns with our results, where a significant portion of tinnitus patients with sleep disorders had psychiatric comorbidities. Similarly, Alster et al.'s work, which suggests a correlation between tinnitus and insomnia, further supports our observation of a high prevalence of sleep disorders in tinnitus patients. In a study conducted in Korea with 122 patients diagnosed with tinnitus, tinnitus handicap inventory was found to be correlated with the Pittsburg sleep quality inventory and the beck depression inventory.[28] Hébert et al.[29] conducted a study with 44 patients, 22 with tinnitus and 22 without tinnitus, and performed one-week sleep diaries, subjective sleep questionnaires, and one-night polysomnographic evaluations. The tinnitus group showed lower subjective sleep quality as measured by the Pittsburgh sleep quality index and sleep diaries, but no significant difference was found in objective polysomnographic sleep parameters. Quantitative non-rapid eye movement sleep analysis found lower spectral power in the delta frequency band in the tinnitus group compared to the non-tinnitus group. In a study conducted by Burgos et al.[30] they compared the polysomnography findings of ten cases with chronic tinnitus and sleep disorders with 20 isolated sleep disorders and 20 healthy controls. In this study, it was determined that tinnitus was associated with subjective and objective sleep disorders. In a very large-scale study conducted in Taiwan using data from the Taiwan National Health Insurance Research Database, 21,798 cases diagnosed with tinnitus and 108,990 controls were included. In this study, the risk of tinnitus was found to be higher in patients with sleep disorders than in those without sleep disorders. And in the same study, the risk of tinnitus was found to be higher in patients with sleep apnea than in those without sleep apnea.[31] In a study conducted by Koning et al.[32] on 165 patients who had complaints of ringing for at least the last month and were diagnosed with tinnitus, it was determined that at least half of the patients had poor sleep quality. If we briefly review a few studies that have been done; in a study conducted by Tyler and Baker on 72 tinnitus cases, 57% had difficulty getting to sleep;[33] in a study conducted by Axelsson and Ringdahl,[34] 10% of cases with tinnitus had sleep difficulties; in a study conducted by Folmer et al.[35] on 190 tinnitus cases, 80% had sleep disturbance; 46% reported sometimes versus 33% often; in a study conducted by Lasisi and Gureje,[36] 52% of cases with tinnitus and 34% of those without had insomnia.

In our study, similar to many studies, the frequency of sleep disorders among patients with tinnitus was found to be 20.5%. This rate is higher than the normal population. As shown in many studies above, sleep disorders are around 10% in the healthy population. This result shows us that there is a relationship between tinnitus and sleep disorders. In our study, we found that the age of patients with tinnitus and sleep disorders was higher. We know that both sleep disorders and tinnitus increase with age.[37] An interesting finding, which is similar to the findings in many studies above, is that the rate of tinnitus was higher in women than in men. It was found that 57.1% of these women were housewives. This may be due to overweight status and daily fatigue. In our study, smoking was found to be higher in the group with sleep disorders and tinnitus compared to the other group. It is know that smoking negatively affects both sleep disorders and hearing physiology.[38,39] We also found that BMI was significantly higher in the group with both tinnitus and sleep disorders. The average BMI in the group with sleep disorders and tinnitus was close to the upper limit of the overweight group. As is known, overweight and obesity cause serious sleep disorders such as obstructive sleep apnea due to the narrowing they create in the upper respiratory tract and the restriction of lung expansion in the thoracic cavity.[40,41]

Our main limitation is that the study has a retrospective design, which limits our ability to confirm cause-and-effect relationships. Additionally, the small sample size and the fact that the study was conducted at a single center may restrict the generalizability of the findings. Another limitation to consider is that the findings related to sleep disorders were derived solely from ICD codes. This approach may not capture the full scope of sleep disturbances in tinnitus patients. Incorporating data from polysomnography or validated sleep disorder questionnaires would have provided more comprehensive and informative insights into the nature and severity of sleep disorders in this population.

CONCLUSION

In our study, 20.5% of the patients with tinnitus had insomnia. Age was found to be an independent predictor in patients with

sleep disorders along with tinnitus. Prospective clinical and experimental studies are needed to clearly understand whether tinnitus causes sleep disorders or sleep disorders cause tinnitus.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was approved by the Gazi Yaşargil Training and Research Hospital Clinical Researches Ethics Committee (Date: 21.07.2023, Decision No: 483).

Informed Consent

Because the study was designed as an animal experiments, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

REFERENCES

1.Shargorodsky J, Curhan GC, Farwell WR. Prevalence and characteristics tinnitus among US adults. *Am J Med*. 2010;123(8):711-718.
2.Saunders JC. The role of central nervous system plasticity in tinnitus. *J Commun Disord*. 2007;40(4):313-334.
3.Han BI, Lee HW, Kim TY, Lim JS, Shin KS. Tinnitus: characteristics, causes, mechanisms, and treatments. *J Clin Neurol*. 2009;5(1):11-9.
4.Langguth B, de Ridder D, Schlee W, Kleinjung T. Tinnitus: Clinical insights in its pathophysiology- a perspective. *J Assoc Res Otolaryngol*. 2024;25(3):249-258.
5.Vijayakumar KA, Cho GW, Maharajan N, Jang CH. A review on peripheral tinnitus, causes, and treatments from the perspective of autophagy. *Exp Neurobiol*. 2022;31(4):232-242.
6.Roberts LE, Eggermont JJ, Caspary DM, Shore SE, Melcher JR, Kaltenbach JA. Ringing ears: the neuroscience of tinnitus. *J Neurosci*. 2010;30(45):14972-14979.
7.Rauschecker JP, Leaver AM, Mühlau M. Tuning out the noise: limbic-auditory interactions in tinnitus. *Neuron*. 2010;66(6):819-826.
8.Shore SE, Roberts LE, Langguth B. Maladaptive plasticity in tinnitus—triggers, mechanisms and treatment. *Nat Rev Neurol*. 2016;12(3):150-160.
9.Shulman A, Wang W, Luo H, Bao S, Searchfield G, Zhang J. Neuroinflammation and tinnitus. *Behavior Neurosci Tinnitus*. 2021:161-174.
10.Reis C, Dias S, Rodrigues AM, et al. Sleep duration, lifestyles and chronic diseases: a cross-sectional population-based study. *Sleep Sci*. 2018;11(04):217-230.
11.Arranz L-I, Rafecas M, Alegre C. Effects of obesity on function and quality of life in chronic pain conditions. *Curr Rheumatol Rep*. 2014;16:1-8.
12.Wang S, Li B, Wu Y, et al. Relationship of sleep duration with sociodemographic characteristics, lifestyle, mental health, and chronic diseases in a large Chinese adult population. *J Clin Sleep Med*. 2017;13(3):377-384.
13.Kales A, Kales JD, Soldatos CR. Insomnia and other sleep disorde s. *Surg Clin North Am*. 1982;66(5):971-991.
14.Medic G, Wille M, Hemels ME. Short-and long-term health consequences of sleep disruption. *Nat Sci Sleep*. 2017:151-161.
15.Uslu H, Uslu GA. The role of sleep deprivation in physiological system dysfunctions. *WJARR*. 2023;20(3):1155-1165.
16.Vernia F, Di Ruscio M, Ciccone A, et al. Sleep disorders related to nutrition and digestive diseases: a neglected clinical condition. *Int J Med Sci*. 2021;18(3):593.
17.Morgan D, Tsai SC. Sleep and the endocrine system. *Crit Care Clin*. 2015;31(3):403-418.
18.Fioretti AB, Fusetti M, Eibenstein A. Association between sleep disorders, hyperacusis and tinnitus: evaluation with tinnitus questionnaires. *Noise Health*. 2013;15(63):91-95.
19.Folmer RL, Griest SE. Tinnitus and insomnia. *Am J Otolaryngol*. 2000;21(5):287-293.
20.Gallo KEB, Corrêa CdC, Gonçalves CGdO, et al. Effect of tinnitus on sleep quality and insomnia. *IAO*. 2023;27:197-202.
21.Kang MJ, Lee Y, Kim YJ, et al. Association between sleep duration and presbycusis in Korean adults: Korea national health and nutrition examination survey. *Korean J Fam Med*. 2023;44(2):117-123.
22.Jiang K, Spira AP, Reed NS, Lin FR, Deal JA. Sleep characteristics and hearing loss in older adults: the national health and nutrition examination survey 2005-2006. *J Gerontol A Biol Sci Med Sci*. 2022;77(3):632-639.
23.Sousa CS, Castro Junior N, Larsson EJ, Ching TH. Risk factors for presbycusis in a socio-economic middle-class sample. *Braz J Otorhinolaryngol*. 2009;75(4):530-536.
24.Paparrigopoulos T, Tzavara C, Theleritis C, Psarros C, Soldatos C, Tountas Y. Insomnia and its correlates in a representative sample of the Greek population. *BMC Public Health*. 2010;10 (1):531.
25.Izuhara K, Wada K, Nakamura K, et al. Association between tinnitus and sleep disorders in the general Japanese population. *Ann Otol Rhinol Laryngol*. 2013;122(11):701-706.
26.Wakabayashi S, Saito H, Oishi N, Shinden S, Ogawa K. Effects of tinnitus treatments on sleep disorders in patients with tinnitus. *Int J Audiol*. 2018;57(2):110-114.
27.Alster J, Shemesh Z, Ornan M, Attias J. Sleep disturbance associated with chronic tinnitus. *Biol Psychiatry*. 1993;34(1-2):84-90.
28.Jeon J-M, Choi S-Y, Lee J-G, Moon JW, Chae S-W, Song J-J. Sleep disorder in tinnitus patients. *Korean J Otorhinolaryngol-Head Neck Surg*. 2021;64(11):792-799.
29.Hébert S, Fullum S, Carrier J. Polysomnographic and quantitative electroencephalographic correlates of subjective sleep complaints in chronic tinnitus. *J Sleep Res*. 2011;20(1pt1):38-44.
30.Burgos I, Feige B, Hornyak M, et al. Chronic tinnitus and associated sleep disturbances. *Somnologie*. 2005;9(3):133-138.
31.Koo M, Hwang JH. Risk of tinnitus in patients with sleep apnea: a nationwide, population-based, case-control study. *Laryngoscope*. 2017;127(9):2171-2175.
32.Koning HM. Sleep disturbances associated with tinnitus: Reduce the maximal intensity of tinnitus. *Int Tinnitus* J. 2019;23(1):64-68.
33.Tyler RS, Baker LJ. Difficulties experienced by tinnitus sufferers. *J Speech Hear Disord*. 1983;48(2):150-154.
34.Axelsson A, Ringdahl A. Tinnitus—a study of its prevalence and characteristics. *British J Audiol*. 1989;23(1):53-62.
35.Folmer RL. Long-term reductions in tinnitus severity. *BMC Ear Nose Throat Disord*. 2002;2:1-9.
36.Lasisi AO, Gureje O. Prevalence of insomnia and impact on quality of life among community elderly subjects with tinnitus. *Ann Otol Rhinol Laryngol*. 2011;120(4):226-230.
37.Schlee W, Kleinjung T, Hiller W, Goebel G, Kolassa I-T, Langguth B. Does tinnitus distress depend on age of onset? *PLoS One*. 2011;6(11):e27379.
38.Colrain IM, Trinder J, Swan GE. The impact of smoking cessation on objective and subjective markers of sleep: review, synthesis, and recommendations. *Nicotine Tobacco Res*. 2004;6(6):913-925.
39.Lin Y-Y, Wu L-W, Kao T-W, et al. Secondhand smoke is associated with hearing threshold shifts in obese adults. *Sci Rep*. 2016;6(1):33071.
40.Isono S, Warner DS, Warner MA. Obstructive sleep apnea of obese adults: pathophysiology and perioperative airway management. *ASA*. 2009;110(4):908-921.
41.Horner RL. Pathophysiology of obstructive sleep apnea. *J Cardiopulm Rehabil Prev*. 2008;28(5):289-298.